

HABITS AND DISTRIBUTION OF THE PSEUDOSCORPIONIDAE, PRINCIPALLY CHELANOPS OBLONGUS, SAY.*

E. W. BERGER, Ph. D. (J. H. U.).

The observations that prompted the writing of this paper were made mainly in Jamaica, W. I., at intervals between the 14th of June and the middle of August, 1897, while the writer was a member of the Marine Biological Laboratory of the Johns Hopkins University, located for that summer at Port Antonio.

Soon after our arrival an abundance of material, with most of the females bearing egg and brood pouches, was discovered upon the Bogg Estate, just to the west of the above named town. The majority of the specimens collected (several hundred in all) belong to a single species, *Chelanops oblongus*. Ten specimens only of another, a smaller, more active species, but with larger mandibles (chelicerae) and with a more rectangular abdomen, were found in the same locality living together with the previous species. This smaller species is *Chthonius pennsylvanicus*, Hagen.

I believe it proper to add here, that I was turned aside from this to other work soon after my return from Jamaica, and that before I had identified these species. Later, when I desired to identify them I had no facilities, and in 1900 sent specimens to the Smithsonian Institution. These were promptly identified for me by Mr. Nathan Banks, Honorary Curator of the Section of Arachnida, as the species above named. I have only recently had the opportunity to identify them for myself at the Ohio State University, using Mr. Bank's key (III).

The Pseudoscorpionidae (Chernetidae) constitute an order in the Class Arachnoidea, or spider-like animals, and some species are very small. The specimens in L. Balsan's list (I) range from 1.20 to 7.10 mm. in length. The *C. oblongus* from Jamaica measures 3.33 to 4.00 mm.; some specimens collected by Professor Jas. S. Hine at Georgesville, Ohio, measure only 2.00 mm., but are evidently not fully matured. The males are slightly smaller than the females. *C. pennsylvanicus* measures 1.90 mm. only. They are called Pseudoscorpions because of their resemblance to real scorpions, except in size and in the absence of the post-abdomen and a poison sting. Many species are blind, including *C. oblongus*; *C. pennsylvanicus* has four small eyes.

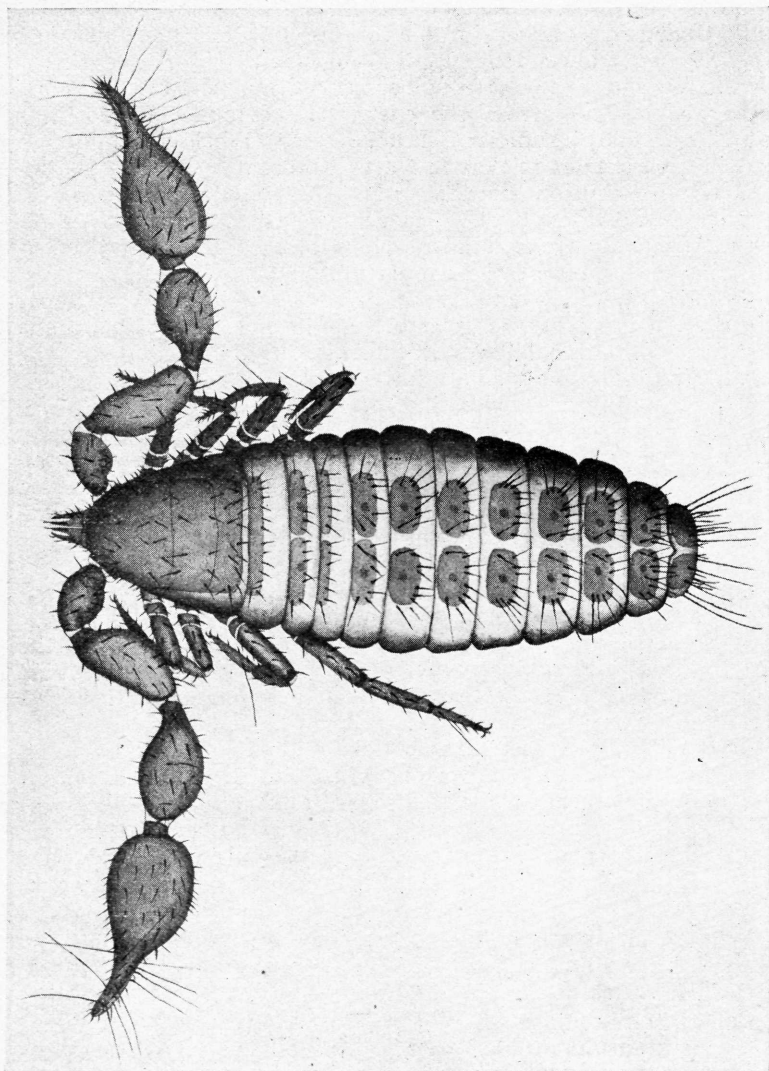
DISTRIBUTION.—I was surprised to find that both the species collected in Jamaica should occur quite throughout the eastern U. S. Mr. Banks names the following localities for *C. oblongus*: Ithaca, N. Y., Washington, D. C., Brazos Co., Texas, Citrus Co.,

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Fla., Sand Point, Fla., Retreat, N. C., Fredericksburg, Va., and Detroit, Mich. (To this list can now be added Port Antonio, Jamaica, and Georgesville, Ohio.); for *C. pennsylvanicus*, Poughkeepsie, N. Y., and Lake Poinsett, Fla. I read over carefully the list named by Mr. Banks in his paper (III) above quoted, for the purpose of noting the distribution north and south, and east and west. I have concluded from this that there are distinct eastern and western species, but probably only a few distinct northern and southern species. Thus Pacific Coast species are reported no farther east than Utah, Montana and Wyoming, while eastern species are reported no farther west than Texas, Kentucky, and Michigan. *Obisium Brunnerium*, Hagen, common in the east, is reported from Utah, but Mr. Banks seems to have some doubt in this case that the Utah species is the same. *Chelifer cancrivorus*, Linn., Faun. Suec., is of course reported from the Pacific Coast and perhaps occurs over the whole U. S., and if not now, will very likely soon occur throughout the entire world. Two or three species are reported only from Texas and Colorado. Eastern and Pacific Coast species, on the other hand, generally have a wide north and south distribution. Thus among other eastern species named by Mr. Banks, *Chelifer biserialatus*, Bks., reported only from Lake Poinsett, Fla., was found by myself under a neglected carpet infested with buffalo moths, at Berea, Ohio, in 1901. The two species collected in Jamaica also illustrate this far north and south distribution nicely, extending even to within the tropics.

This wide north and south distribution of the species of pseudoscorpions versus their rather limited east and west distribution, I believe is associated with the migration of insects or birds. Pseudoscorpions have, however, to my knowledge, never been found upon birds, so that nothing definite can be stated in this respect. On the other hand, they are known to cling to insects (chiefly flies and beetles) and arachnids (see ASSOCIATIONS WITH INSECTS) and to be transported from place to place by these. Certain insects are known to migrate for hundreds of miles. Thus a moth, the Black Witch, *Erebus odora*, is supposed to migrate from the West Indies and Mexico to the U. S., while the Monarch, *Anosia plexippus*, is believed to migrate south in fall and north in Spring. No doubt there are other migratory insects, so that the distribution of pseudoscorpions will, I believe, sometime find its explanation in this direction. There being nothing like a complete list of pseudoscorpions in existence, it is evident that these speculations are somewhat tentative.

I tried to gain some idea of the distribution in South America by comparing the papers of Ellingsen (VIII), Balsan (I) and Banks (III). I found no species mentioned that are common to



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Chelanops oblongus, female.

both North and South America. Two species, *Chelifer canestrinum*, Bal., and *Chelifer longichelifer* occur both in Ecuador (Guayaquil) and in Venezuela, i. e., to the west and east of the Andes. Two other species from Venezuela occur in Paraguay and Uruguay. Hagen in one of his papers (IX) mentions *Chelifer americanus* occurring in Venezuela and South Brazil. Of the few species noted from Peru and Chili, west of the Andes, none are reported from the east. The evidence from South America, while insufficient, I believe nevertheless suggests a distribution similar to that in North America.

The distribution of the order Pseudoscorpionidae is, of course, worldwide: North America, South America, Europe, Asia, Africa, Australia, Madagascar, Sumatra and New Celebes, each having representatives reported.

HABITATS.—I collected almost all my specimens from under the loose bark of flat-lying trees. A few were found in banana plant rubbish (dried leaves, pieces of stems, etc.) and in dead pines (Pine here refers to a relative of the pinaepple that grows as an aerophyte upon trees in the tropics.) While I could not state that pseudoscorpions are social in their habits, I always felt that when I found one, others were not far away, and that they were scattered in groups rather than singly. It is also interesting to note that the places of occurrence of these species in Jamaica were always damp or even wet: frequently so wet that I could press water from the bark and wood with my fingers. I never found them in dry places, and when I kept some in captivity under small pieces of bark in glass jars, I found that they died and dried up if the bark was not kept quite moist and the jars covered. By taking proper precaution, however, to provide moisture, several colonies were kept alive for about ten months. In one instance I prepared a roll of bark about a core of decayed wood and set it one end in a glass jar. This worked very well, the animals living between the layers of the bark and wood. In this jar and others some females even produced eggs, and some young were hatched. To keep water from condensing upon the sides of the glass, I lined the jars with filter paper. Not all pseudoscorpions, however, require such wet conditions; thus *Chelifer biseriatus* already referred to, and *Chelifer cancroides*, the book scorpion, both live in very dry places in houses. Other localities where these little creatures find their abode are: upon the leaves of trees (palmetto), between the crevices of rocks, under rocks, driftwood and leaves in the woods. *Obisium maritimum*, Leach, and *Chelanops tristes*, Bks., live under stones between tide marks: the former on the Isle of Man and other British Isles, the latter on Long Island, N. Y. Immes, who reports the former species, suggests that it retains sufficient air in its tracheae to keep it alive during high tide.

These two species represent the extreme in wetness to which members of the order have become accommodated.

To this list of habitats must be added parasitism and commensalism, habits which the order has developed in connection with other insects.

ASSOCIATION WITH INSECTS, FOOD.—Pseudoscorpions evidently associate themselves with insects and a few arachnids in three ways: as travelers, parasites and commensalists. As travelers they make use of insects and other arachnids by holding fast with the chelae of their pedipalps to the legs of flies, bedbugs, phalangids (harvestmen), tipulids (crane flies), etc., or by concealing themselves under the elytra of the larger beetles, *Alaus oculatus*, and others. It appears that in the tropics they are more often reported upon beetles, while in the north more frequently upon flies and the other insects named.

As supposed parasites they occur mainly upon beetles. The cases of Chernetidae on record, occurring under the elytra and wings of beetles where the body is softest, seems to make this belief probable. I see no reason why it should not be easy enough for a pseudoscorpion to penetrate the softer parts of a beetle with its sharp mandibles.

In commensalism the species of insects with which they are associated are probably the same as in parasitism. The truth is, it would be quite a difficult matter to name either the species of insects or of pseudoscorpions that belong strictly to any one of these three groups. Since pseudoscorpions are carnivorous, sucking the juices from smaller insects, mites, etc., it appears not at all improbable that they should find their prey under the wings of a beetle, and stay there until the supply is exhausted.

I, myself, have found neither *C. oblongus* nor *C. pennsylvanicus* upon other insects, but Hagen (IX) reports it (*Ch. alius*, Leidy) under the elytra of the beetle *Alaus oculatus*. He further states that blind Chernes species travel mainly upon beetles, and mentions *Chelifer americanus*, De Geer, on *Acanthocinus longimanus* in Venezuela and South Brazil; another in Brazil on *Passalus*; and one in Melbourne (together with a tick) upon *Passalus politus*; all occur under the elytra. A special few, he says, travel fastened to flies, as *Ch. Sanborni* in Mass. and *Ch. Loewii* in Panama. Hagen evidently favors the transport theory and believes that certain species limit themselves to certain species of flies, beetles or other insects. Moniez and Wagner also favor the transport theory.

Other writers favor either parasitism or commensalism. Thus Leydig in discussing the occurrence of a pseudoscorpion under the wings of a Brazilian beetle, emphasizes the fact that they are located under the wings where the abdomen is most vulnerable, and believes in parasitism. Thering believes in com-

mensalism, and mentions species of *Pyrophorous* between which and the pseudoscorpion he thinks a definite relation has been established; but he admits that the species upon leaves are probably the same as upon the beetles.

As will be seen in the following topic pseudoscorpions evidently do attack and may cause the death of flies much larger than themselves. It occurs to me that this instinct for robbery is the starting point that lead to the habit of holding fast to insects for travel, to parasitism and to commensalism, in whatever degree these exist as a habit. It is perhaps natural for a pseudoscorpion to lay hold of anything alive that comes within its reach. I have distinct recollections of teasing specimens with a needle or with a splinter, and that they would lay hold of these objects with their chelae. If, then, the attacked insect is strong enough to walk or fly away, and the pseudoscorpion does not kill it, he becomes a passenger; if he finds natural secretions or succeeds in wounding his host, he is a parasite; if he finds other insects or mites that serve his wants, he is simply a commensalist. It is thus quite easy to understand how the three conditions of travel, parasitism and commensalism may have developed as a habit, if indeed they are not accidents, for pseudoscorpions can live very well without hosts.

FOOD, CANNIBALISM.—As I have stated before, the food of pseudoscorpions is the juices of insects, mites, etc., usually smaller than themselves. I have seen specimens holding some smaller insect either by means of the chelae of the pedipalps or by means of the chelicerae. It is generally known that they feed upon psocids (corrodentia) and Hagen mentions *Atropus pulsatorius*, the death watch, as their probable food. On the other hand, I have found them (*Chelifer biserialum*) associated with buffalo moths and believe that they were there because the moths were abundant and good feeding.

The following observations by Bachhausen are important and interesting. Thus Prof. C. Berg reports (V) that Bachhausen in South America found a pseudoscorpion attached to the leg of a blow-fly and hanging free. He noticed after several hours that the legs of the fly became stiff. The next morning the fly was dead and the pseudoscorpion sucked full under some scraps of paper. Bachhausen next hungered a number upon moss under a glass and then gave them some small flies. The pseudoscorpions soon appeared from concealment and began to attach themselves to the legs of the flies by one pedipalp. When two happened to get the same fly one or the other soon let go in order to get a victim of its own. The legs of the flies soon become stiffened and when the flies died they dragged them into concealment. A tabanus is reported as dying much slower than the other flies. On the other hand, Muehlhausen does not find that

the fly's leg was stiffened by a *Chelifer cancroides* (the book scorpion), which held fast for fifty-six hours, or until it was drowned in a drop of milk. Nor did the microscope show any evidence of injury to the fly's leg. It occurs to me, however, that *C. cancroides* is one of the smaller species and consequently was not able to injure the fly's leg as an individual of a larger species could have done.

Cannibalism.—I observed several times, while collecting specimens, that large individuals were holding smaller ones in their chelae. I also observed the same thing upon some specimens kept in the jars (see CAPTIVITY). Then, again, the specimens in the jars were continually on the decrease. From these several observations I am led to believe that *Chelanops oblongus* and other pseudoscorpions are cannibalistic. On the other hand, the immature of *C. oblongus* and other pseudoscorpions build small nests in which they live (or rather become torpid) during their moulting periods and in which they remain until their cuticle has hardened (see BREEDING). This evidently indicates danger from enemies and probably from their own kin. I believe rather more from their own kin than from other enemies, since the places where pseudoscorpions live are small and they could easily crawl into some crevice where a larger enemy could not reach them. I furthermore found but few insects and other animals under the bark of sufficient size to be of much danger. These considerations strengthen my belief in the probability of cannibalism. I know of no writer who has made similar observations.

CAPTIVITY.—In the three jars used for confining live specimens I kept from thirty to forty for nearly ten months. I can perhaps best give the history of these by quoting the brief notes verbatim.

Jar A. Sept. 3d.—All seem contented. Found one specimen carrying a smaller one in his jaws. Is this *cannibalism*? Found one with a small bunch of yellow eggs.

Sept. 30th.—I find fewer specimens, but all appear happy. There are none with eggs. There is a plenty of other little insects and mites in all the jars; also some small earthworms.

Oct. 21st.—There are now only five specimens and none with eggs.

Jar B. Sept. 4th.—This jar had three specimens with bunches of yellow eggs, and other specimens with and without small eggs. I can find nothing of those with eggs today. Found small one building a casting nest. No evidence of eggs on any, but I had no lens with which to examine them. Bunches of eggs may be very small at first, quite colorless and difficult to see without a lens or without turning the animals over.

Sept. 30th.—I found none with eggs and fewer specimens. What has become of them? Some doubtless lost their life by drowning in drops of water precipitated upon the glass, but this does not account for all missing.

Oct. 20th.—Found two dead and one small one alive. Found one in moulting nest preparing to cast.

Jar C. Sept. 7th.—Bark arranged in concentric layers and populated with adults. All seem contented. Found eight specimens with yellow bunches of eggs. One encased in moulting nest. One with small one in jaws (cannibalism?) No small ones were put into this jar nor any with eggs.

Sept. 30th.—Looked over Jar C where previously there were adults with eggs, and now I find none. The number of adults is fewer. What has become of them? Do they eat each other and also the females with eggs? Have not noticed any undue amount of empty skins, did however observe remnants of pedipalps, etc., at the bottom of the jar.

Oct. 21st.—There are now eight specimens living and four found dead. None with eggs. One small one in moulting nest preparing to cast, found Oct. 20th, casted Oct. 23d, but at eleven a. m. still in the nest. Two days later "baby" is out of its nest and under bark.

June 3d, 1898.—All specimens are dead in all the jars. Some shells and claws of them only can be found. Some little white hexapods, also some black ones, and some small mites are living in the jars.

BREEDING, NESTS, MOULTING.—The genital opening is located ventrally between the second and third abdominal segments, and it is here that the female carries her eggs in a small whitish pouch. The young are hatched within this pouch and remain there until ready to shift for themselves, being nourished in the mean time by a fluid secretion from the mother. This secretion is produced either by the oviduct or by some other glandular structure within the genital opening. The pouches enlarge as the young increase in size, until they become quite cumbersome for the mother to carry. I have counted twenty-four eggs in a pouch. Metchnikoff says about fifty and that they are one-tenth of a millimetre in diameter. Barrois says that he found about thirty. It is generally understood that the young are nourished in the pouch.

Moulting Nests.—I shall next describe more fully the moulting or casting nests. These are composed of a wall of small fragments of wood and bark that completely incloses a circular or oval space three to four millimetres in diameter. One of these little nests extends from the wood of the tree to the bark, and is lined with silk. When a young specimen is ready to shed its skin it builds one of these nests, suspends itself

within, supported by several fibres of silk which cross and recross the enclosed space, becomes torpid and moults in two or three days. It then remains in its nest for one or two days longer, or until its cuticle hardens, when it is ready to break through the wall of its little prison. (See notes Jar C above; also figure.)

Some writers convey the idea that these nests are built by the mother for the entire brood after they leave the pouch, and that they remain there until sufficiently hardened. Judging by my own observations this is not the case. I have never found but a single specimen in a nest of this kind, and that always an

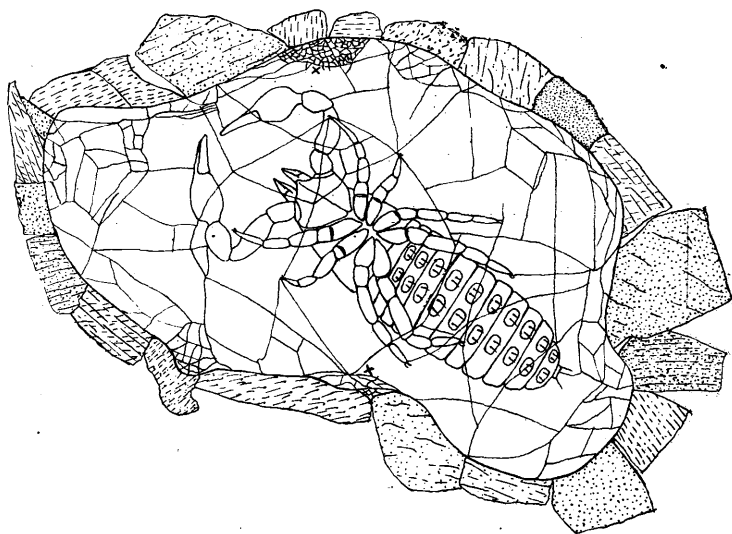


Fig. 1. Moulting Nest of *Chelanops oblongus*.

immature one. (I collected and observed not less than two dozen such nests.) Furthermore, I usually found the empty skin in the nest and sometimes the skin and the animal, in fact I all but saw them in the act of moulting. (See notes under Jar C.) As I have never found an adult, with or without eggs, in a nest, I think there can be no doubt that the casting or moulting nests are built by single immature individuals for a safe retreat during moulting and not by the parent for the entire brood. Mr. Banks has this statement in his paper (III) which corresponds exactly with my observations: "Many were young and had formed little cases of silk and earth in which to pass the moulting period." This was reported by Mr. Hubbard for *Garypus bicornis*, Bks., which lives between the laminae of rocks at Specimen Ridge, Yellow Stone National Park.

The following observations by J. Barrois (IV) upon a chelifer living in the temperate zone are interesting, and show that females may build nests, but evidently for themselves and not for the brood. This chelifer was found in small closed nests under rocks. Only the females built the nests. The males hid as best they could and were smaller and fewer than the females. Between October and February the occupants were plump with swollen abdomens. By the end of April or May the nests were empty or contained only an emaciated female. The eggs were not laid before January, but after that they were found in a packet adhering to the vulva, with the cavity of the packet in free communication with the oviduct, evidently a nutritive adaptation. Here we see how the female uses a nest for another purpose. In the tropics where my observations were made, such an adaptation would hardly be necessary and I do not think that it exists.

Moulting.—I made no observation indicating the number of times pseudoscorpions moult. That they moult after becoming sexually mature is probable from the fact that the normal genital openings appear when they are about three-fourths grown and that they produce eggs at that stage. Smaller animals show no signs of genital openings. Then again, a case of regeneration of a pedipalp (descr. below) indicates that mature animals probably moult even when apparently full grown. In arthropods generally the enlargement of a regenerating organ takes place at moulting time, in fact regeneration presupposes moulting, and if the same rule holds true for pseudoscorpions, it suggests that older specimens may moult. (See, however, *Moulting Nests*.)

The manner of moulting is as follows: The dorsal skin of the cephalothorax splits at the anterior and lateral margins, remaining hinged posteriorly. The animal then extricates itself through this opening. This is the situation indicated by the exuviae examined, in which this skin exists as a hinged lid.

Regeneration.—I found a few specimens that had lost one to several segments of the pedipalps, and one specimen with a large (normal) pedipalp and a small one of about half the normal size. The smaller pedipalp was of lighter color and thin, and in every way suggested a case of regeneration similar to that found in crabs.

BODY MOVEMENTS, LIGHT OR HEAT.—A pseudoscorpion can retract one or both of its chelicerae and move them in any direction. The pedipalps can be moved in any direction and the trochanter and femur folded back almost against the sides of the body, the tibia and the chelae, or hand, extending forward. It cleans the chelae of its pedipalps with its chelicerae, or mandibles, using them either singly or as a pair. The legs are used in pairs when walking, and those of each side constitute

two pairs, an anterior and a posterior pair. When at rest the two anterior pairs extend forward and the two posterior pairs backward from a right angle with the body. When walking it uses its *four pairs* of legs quite as any four-footed animal uses its legs. When disturbed it contracts its abdomen, the latter thus becoming shorter and thicker.

I focused the direct sunlight from a small engraver's lens upon the desk, the specimen being under a watch glass. It appears that in a few instances the animal took note of the focus and went around it. It seems to have become conscious of the focus by reaching into it with its pedipalps. At other times it walked right through the focus without any concern whatever. Once I directed the focus upon the cephalothorax for some little time, when all at once it seemed to feel something, probably the heat of the focus, and it hurried away apparently discomfited. No eyes could be discovered, and the above experiments, I believe, simply indicate that the animal felt the heat of the focus. With a lens I could make out in many instances light circular disks near the anterior lateral margins of the cephalothorax. These were very suggestive of the so-called eye spots of the eyed elaters.

COLOR.—The color of the adult is light brown, with the pedipalps, the dorsal part of the cephalothorax and the dorsal plates of a darker shade. In newly moulted specimens the appendages are of a light slate color, sometimes of a green or blue cast, or cream color, while the body is of a uniform yellowish brown or cream color, with the dorsal plates not well marked off.

ECONOMIC VALUE.—To what extent these little animals serve any useful purpose in the destruction of insect pests, is not well known and difficult to determine. But, since they are carnivorous, we may imagine that they destroy many small insects, larvae and mites that would otherwise be harmful; and if Bachhausen's observations are correct, many flies, and perhaps other insects larger than themselves. The book scorpion no doubt serves a useful purpose in keeping down the number of book-lice, and to what extent this is done might be a subject for investigation. On the other hand a more complete study of the group may show us more clearly its economic value.

The writer desires to express his sincere appreciation to Professor Osborn for his interest manifested in this paper and for the publication of the same as a University Bulletin.

Biological Hall, Ohio State University, November 24, 1905.

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DESCRIPTION OF FIGURES.

Plate XXVIII.—*Chelanops oblongus*, female. The long hairs upon the chelae, the chelicerae, the cephalothorax, the dorsal scutae and at the posterior end of the abdomen are exact copies of nature. The second visible segment figured on the legs is not movable upon the third segment and is properly speaking not a joint.

Fig. 1.—Small immature *C. oblongus* in a moulting nest. Notice lining of silk at X; this was not sketched over the entire inside of the nest as it would have obscured the fibres that support the animal. Hairs on ventral scutae are as in nature. Note that one leg lacks a segment; this is as in nature. Sketched from living animal (torpid) in the nest. While drawing I noted two droplets of liquid accumulate near a joint and spread over the surface.
